Discovering the Candidate Routines for Robotic Process Automation using Machine Learning Cognitive Capabilities

SHORT SYNOPSIS

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Certificate

I hereby declare that the short synopsis entitled "***Discovering the Candidate Routines for Robotic Process Automation using Machine learning cognitive capabilities***" is being submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in the Department of Computer Science Engineering under the Faculty of Engineering & Technology, Manav Rachna International Institute of Research & Studies, Faridabad during the academic year 2021-22.

It is a bonafide record of original work carried out under the supervision of **Dr. Supriya P. Panda** and has not been submitted in full or part to any other university or institute for a degree or diploma. Further, it is certified that the short synopsis is plagiarism-free and the proof has been submitted.

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ABSTRACT

Automation and Digitization are the highest strategic agenda for many giant organizations. Businesses are rushing to find new ways to automate their business procedures. The dawn of new technologies ushered in a new era of advanced business acronyms in the way of working. Artificial Intelligence (AI) and its related technologies, such as Natural Language Processing (NLP), Computer Vision, Machine Learning (ML), and Robotic Process Automation (RPA), have given rise to a completely new method of Business Automation.

The RPA is a software solution that mimics human behavior, similar to a "Software ROBOT", and is configured and programmed to perform repetitive organizational tasks normally performed by humans. The RPA is an emerging field that focuses on automating business operations with deterministic outcomes and repeated routines. The RPA is used to validate business proposal contracts, consumer credit lines, insurance premium sales, and maintain personnel data.

Business giants like Telephonic O2 and Xchanging have seen their costs reduced by 30 percent and 800 percent, respectively, as a result of RPA deployment. The RPA has a lot of value and potential, but it also has some drawbacks. The first hurdle is to identify a business process that can benefit from RPA. The second task is to use AI-enabled technology to improve RPA's cognitive abilities. Using Robotic Process Mining (RPM) and Process Quality-based characteristics, this research intends to offer a framework and develop standard criteria for evaluating the automation potential of business processes. The next goal is to employ AI and machine learning to improve software decision-making skills by testing the offered solutions on a big dataset in a case study.

Keywords: — *Robotic Process Mining (RPM), Machine Learning, Intelligent Process Automation, Robotic Process Automation, UI Logs, Virtual Software Agents*

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1. Introduction

1.1 Automation

Enormous Automation led the organizations to uncover innovative and digital technologies to renew their business models to adopt automation. It is observed that organizations are under extreme pressure to automate and digitalize their business processes (Kohli, R., and Melville, N. P., 2019). Organizations are in a hurry to quickly complete the back office processes and are looking for different ways to cut the cost.

The roaring technology of Artificial Intelligence (AI) induced us to spot new areas of automation and to solve the questions "what is to be done by humans and what is to be automated?" - RPA is the solution to this problem.

1.2 Fundamental Understanding

1.2.1 Business Process: A business process consists of set of business tasks and activities to be completed in a chronology to get the work done (Chakraborti, T., Isahagian, V., Khalaf, R., Khazaeni, Y., Muthusamy, V., Rizk, Y., and Unuvar, M., 2020). These processes are generally structured and have predefined goals to accomplish. The main aim of a process is to establish a commonly implicit flow so that all the tasks can be accomplished consistently and efficiently. Some common business processes are Registration, Purchase-to-Pay (P2P), Order to Cash (O2C), Inventory Management, Order Management, Procurement or Customer Services Processes (UiPath, n.d). Every process consists of certain steps that are generally documented in event logs. UI Interface Logs files particularly record all the mouse and keyboard clicks and events performed by different users in a process (UiPath, n.d.).

1.2.2 Business Process Management: Efficient processes are a long term goal of enterprises. Business Process Management ascertains that all the processes are aligned with organizations business goal. It is a multidisciplinary field to control a business process in terms of its execution, controlling, modeling, automation, estimation and optimization Business Process Management is a vital task to survive with competitive market situation and helps in digital

alterations. BPM helps the business analyst to identify which process to automate. Automation of some of the repetitive processes helps to improve the competence of a business processes (Leno, V., Polyvyanyy, A., La Rosa, M., Dumas, M., and Maggi, F. M., 2019). A Business Process can be visually depicted using Business Process Mode and Notation (BPMN, n.d.).

1.2.3 **Process Mining:** It is the continuous monitoring of a process to see the insights of a process. Process mining identifies the bottlenecks and deviations of a process. Process Mining helps to discover the processes or parts of the processes for automaton Organizations IT applications record every activity and transaction that happens within each stage of a process. This is called as "event" and this data from event log forms the basis for process mining. Celonis Intelligent Business Cloud (Celonis, n.d) offers RPA review apps that supply the process analytics capabilities to help customers to determine and prioritize RPA executions and costing impact.

1.3 Robotic Process Automation (RPA)

RPA is an automation technology that builds "Software bots" to mimic human actions by interacting with the organization's IT System. RPA always misunderstood with the ROBOTS with hydraulic arms and rubber tracks (Accenture, 2016). RPA is a software based solutions to complete the structured, rules based and repetitive tasks of a business process (Accenture, 2016). RPA is a proxy to human tasks force (Lacity, M. C., and Willcocks, L. P., 2016). RPA sits on the top of the organizations IT support system and applications and delivers values to the processes (Le Clair, C., Cullen, A., and King, M., 2016). For example a "software virtual agents/software robot" is configured to copy and paste structured data from an excel file to a User Interface of an information system, thereby executing some predefined process (Jha, N., Prashar, D., and Nagpal, A., 2021).

The RPA do not disturb the underlying Information System's programming but rather it works on the top of it (Juntunen, K., 2018). RPA works by tracing and recording the User Interface events like clicking of mouse, ragging, dropping and linking icons on the screen

etc. RPA doesn't need any data model or a database like BPMS systems as it does not store any data.

1.4 Types of RPA Tools:

WillCocks et al. (Willcocks, L., Lacity, M., and Craig, A., 2017) spell out that there are three types of RPA software products.

i **Desktop RPA Tool:** These tools works like an excel macro. These tools use screen scraping technology to record User Interface events like what a user does on his/her desktop including capturing keystrokes from keyboard events and mouse clicks. This tool is like a good desktop assistant as it does not involve in any kind of transactions. It just simply replaces the keyboard and mouse actions. These kind of tools won't be able to predict why a process gone wrong. But these kinds of tools are easy to use.

ii **Enterprise RPA Tool:** These tools are commonly objects and carry out tasks from the component libraries. They are installed and build up on Servers to access the component libraries by logging on and off various systems. Enterprise RPA tool require a consistent infrastructure, architecture, security and IT governance. These tools can be hurriedly deployed, recycled and scaled. The enterprise expertise can be amplified by setting up adaptable robots teams.

iii **Professional IT Software Development Tools:** These tools consist of the Business Processing Modeling tool and Software Development Toolkit. These tools are used by the skilled domain experts (IT Programmers, Technical Team) with good programming knowledge. Firstly quite a few business processes are examined by the Subject Matter Experts and then after analyzing it, the Technical team proceeds for automation. These tools can be embedded with heavy IT projects. The first two tools do not disturb the existing IT system.

Organizations also lack a concrete approach to mine RPA process value (Le Clair, C., Cullen, A., and King, M., 2016). Matching different business processes with RPA is a challenge (Juntunen, K., 2018). Processes with routine tasks are the prime RPA Targets. Medical claims processing, rerouting the requests to humans for further help, Credit Authorizers,

Office Clerical jobs, Order processing teams, loan interviewers, back office teams, fraud checkers do tasks which have a high potential for automation.

Organization must first automate a smaller and low-risk task. If the automation turns out to be a success then an organization begins to automate its entire business processes (The Institute for Robotic Process Automation, 2015). RPA is perfect for non-subjective, repetitive and high-volume manual tasks. High degree of standardization and high volume are important to choose the process for automation (Wanner, J., Hofmann, A., Fischer, M., Imgrund, F., Janiesch, C., and Geyer-Klingeberg, J., 2019).

1.5 RPA Vendors

The RPA Business vendors have observed an upsurge in the field of automation. UiPath, Blue Prism, Automation Anywhere, Accenture, cognizant, Automation Edge are leading RPA Providers that are dominant in the Automation industry(Van Der Aalst, W. M. P., Bichler, M., and Heinzl, A., 2018). The top RPA providers were Blue Prism, Automation Anywhere and UiPath as per market share 2020(UiPath, n.d.).

New horizons for RPA needs to be explored with other technologies like Chat bots, NLP, speech recognition, image recognition, machine learning and AI (Jha, N., Prashar, D., and Nagpal, A., 2021). RPA can start from small scale and then can leverage up to enterprise-wide by using AI and machine learning (Juntunen, K., 2018). The cognitive virtual agents have been build up to work with humans and to support the human tasks force to focus on some high order tasks like decision making (The Institute for Robotic Process Automation, 2015).

1.6 Benefits of RPA

The RPA market is around $4 billion in 2020 and has a growth rate of 30% to 40% (Lacity, M., and Willcocks, L., 2021). 54% of Australian organizations (Juntunen, K., 2018) are using RPA thereby improving their Productivity, customer satisfaction, quality and operational efficiency and are reporting cost savings. RPA technology cuts the cost of an off-shore Full-Time Equivalent (FTE) in half. RPA freed the back office workers with the bored, dull and

tedious task. According to a report by McKinsey and Company estimates that around 110 to 140 million Full Time Equivalent(FTE) will be replaced by automation tools by 2025 (Manyika, J., Chui, M., Bughin, J., Dobbs, R., Bisson, P., and Marrs, A., 2013).

Many organizations have witnessed the improved customer satisfaction and cost savings in terms of replacing the Full Time Equivalent with smart virtual robots (Sicular, S., Brant, K., and Gartner, G. I., 2018). Others find it difficult as they have very few processes, which are highly standardized, automotive and repetitive task. There are other reasons, like security, training the current staff, technical feasibility due to which these organizations are not able to get ROI (return on investments) on RPA projects (Willcocks, L. P., Lacity, M., and Craig, A., 2015).

1.6.1 Case Studies of RPA Implementation

A number of case studies as depicted in Table1 imitate how RPA technology has amplified the competence and precision of the business process involving the human workers. O2 and Vodafone have greatly enhanced their business processes in terms of cost benefits and FTE as a result of RPA adoption (Willcocks, L. P., Lacity, M., and Craig, A., 2015). Xchanging (Willcocks, L. P., Lacity, M., and Craig, A., 2015), a London-based business process and technology service provider, automated its 14 core processes and deployed 27 robots to handle 120000 monthly transactions. Xchanging main back office tasks are to process insurance premiums so that the insurance brokers get paid. It configured RPA for the structured part of the process like receiving the online data, finding the errors, producing the authorized sales record and informing brokers. Enterprise wide process automation is implemented in Xchanging. Global Telecommunication Giant Vodafone realize RPA and Process mining to attain an order rate of 92% and trims down it purchasing costs. University Hospital Birmingham (UHB) (Primer, A., 2015) National Health Service Foundation Trust used the RPA technology to trim down the time it took to register patients. The patient administration system is automated thereby reducing the overhead of staff by registering 50 % more patients to register. After using RPA in PAS some of the other processes are automated by the hospital like job transfer data, pharmacy stock control updates, outpatient appointment outcomes, and system monitoring. By deploying RPA, one can save up to 40%

on digital labor expenditures. Table1 discusses RPA technology boosted efficiency and accuracy of the business process.

Table1: RPA technology boosted efficiency and accuracy of the business process: source (Willcocks, L. P., Lacity, M., and Craig, A., 2015)

S. No.	Organization / Company Name	No of Business Processes to be Automated	No. of transaction processed per month	No. of Virtual Agents/ Software Robots	Cost Savings	Benefits	No. of Employees replaced by Robots /Full Time Equivalent (FTE)	RPA Provider/ Vendor	RPA Implementation Phase (Time Line)
1.	Xchanging	14 Core Processes	12000 Per Month	27	30%	Building in-house RPA capability, scalability, Higher Accuracy	NA	Blue Prism	2013-2015
2.	TelefonicaO2	15 Core Processes	400,000 to 500,000	160	800%	Workforce flexibility, turnaround time for customer call's cut t o just minutes, high compliance, service excellence	100	Blue Prism	2010-2015
3.	University Hospitals Birmingham	6 Core Processes	All the transaction of PAS(Patient Administration System)	-	50%	Fast, easy to use, customer satisfaction, efficient, improved operational speed and performance	NA	Blue Prism	2014

2. Literature Review

The RPA Technology has its initial emergence in 2000's (UiPath, n.d.). The history of RPA is difficult to understand as organization uses automation since decades. RPA uses Screen Scraping, Workflow Automation and AI tools to automate the business processes. The software automated the manual entry of customer contact information, totaling of invoice and sending voice emails to the customers. After a comprehensive study of approximately 40 research papers, conducting a literature review has been possible in understanding the existing landscape within RPA, Relevant 30 papers as listed in the references have provided insights, offering perspectives, methodologies and findings.

Phil Fersht, the founder of Horses for Sources (HfS), coined the phrase "ROBOTIC AUTOMATION" in 2012. Later on Patrick Geary, the chief marketing officer at Blue Prism named its products as Robotic Process Automation (RPA). After that the other vendors started renaming the product as RPA Tools (Willcocks, L., Lacity, M., and Craig, A., 2016).

Willcocks, L. P., Lacity, M., and Craig, A. (2015) described that RPA is a "software bot" which substitute human tasks force by executing certain desktop scripts using screen scraping tools.

Asatiani, A., and Penttinen, E. (2016) presented an outline of OpusCapita, a financial firm. OpusCapita offers Process automation services to large financial organizations. OpusCapita group is specialized for automating the 'Comprehensive Purchase-to-Pay and Order-to-Cash processes'. Virtual software robots can be set up very easily and in very less time as 2-4 weeks. Asatiani specified some of the RPA's limitations as i) RPA's lack of connectivity with backend systems (machine to machine communication), (ii) RPA's promise in outsourcing a business function, (iii) RPA implementation causes a fuss among current employees, regardless of the reality that no proof of job losses has been recorded in firms that use RPA tools.

Aguirre, S., and Rodriguez, A. (2017) focused on the relevance of RPA in front office and back office business processes. Back Office Business Processes like accounts receivable, accounts payable, travel, billing, fixed assets are good contenders for RPA implementation.

Author provides difference between RPA and Business process management systems. Aguirre suggests some criteria to choose business process for RPA implementation. (i) Processes with Low cognitive requirements and the tasks that does not requires subjective judgment, ingenuity or construal skills are the best processes to be automated. (ii) Voluminous process (iii) Process that necessitate admittance to numerous applications and systems to perform the job. (iv) Process standardization (v) Human error prone tasks in processes owing to manual labor. An evaluation is done to assess the performance of RPA and human agents with a case study for a BPO provider located in Bogotá, Columbia. The back office operations are replaced by software Robotic Agents. The productivity is improved by 21 % however time reduction was not happened.

Van Der Aalst, W. M. P., Bichler, M., and Heinzl, A. (2018) also focuses on the main research questions like (i) which process should be chosen for automation What could be the potential characteristics of a business processes for RPA implementation? How the exceptions and errors could be handled if any bot goes wrong? RPA technology can be enhanced by using AI/ML. ML algorithm can interpret the changing user interfaces by training the software bot with various training examples. The RPA software agents can learn by doing. This makes it different from the traditional web scarping tools. According to him "bots" can be configured in between of a running process where we find the repetitive tasks.

Geyer-Klingeberg, J., Nakladal, J., Baldauf, F., and Veit, F. (2018) emphasized the importance of process mining in successful implementation of RPA robots. According to him there is a continuous need to monitor the performances of these virtual software agents. The authors suggests three-step approach for process automation. (i) Assessing RPA potential: to identify the suitable candidate processes for RPA implementation. The process should be repetitive, scalable and standardized. (ii) Developing RPA Application: building the scripts for software robots. (iii) Evaluate the results: the trained robots work can be evaluated using a Process Mining Application. The automotive and non automotive processes are analyzed for the most efficient and thriving RPA implementations. Purchase to Pay (P2P) is a business process which provides high potential for RPA implementation. Geyer explains 4 key drivers for RPA and process mining. (i) Select an appropriate use case based on the maturity and

standardization of a process. (ii) Standardization before automation: to be able to implement a RPA, a process has to be standardized with minimal distractions, so as to achieve higher return on investments. (iii) Prioritization of activities: Process which has low automation rates is the best candidate to implement RPA. Central coordinating unit: (iv) A central task to prioritize the potential process and to coordinate all the RPA implementation activities.

Leopold, H., Aa, H. V. D., and Reijers, H. A. (2018) tried to spot out the challenge to categorize the suitable candidate processes for automation. A supervised machine learning approach is used to discover the degree of automation of tasks depicted in a textual process description. The ML Algorithm classifies the process as an automated, a manual or a human interaction with an information system process. 47 textual process descriptions out of 424 activities are used as a dataset for training the classification algorithm. The Linguistic preprocessing step joins both VerbNet and Stanford Parser to mine the verbs, objects, roles in the tasks and categorized these into Verb feature, Object Feature, Resource Type and IT Domains. Support Vector Machine (SVM) is used to classify unseen tasks, whether it is an automated, a manual or a human interaction. SVM and JWNL are used in WEKA. 324 tasks are implemented correctly out of 424 activities from 47 textual process descriptions. F1-Measure is 81%. The future scope is to add more features and test other classifiers.

Jimenez-Ramirez, A., Reijers, H. A., Barba, I., and Valle, C. D. (2019) proposes a method to improve the analysis and design phases of a process for its successful RPA implementation. Logs are created for mouse-keyboard events, mouse and keyboard actions on screen with their timestamps. These logs are converted in to UI logs by using image-analysis method. Underlying Process Models are prepared by process discovery algorithm. Two BPO use cases are used to implement the method. The future scope of the research is (i) to boost further phases of RPA implementation using the UI logs, (ii) to reflect on expert's opinion to discover process models (iii) to use other process discovery algorithm to make a final model and to remove the noise in the UI logs using screen-scrapping tools.

Wanner, J., Hofmann, A., Fischer, M., Imgrund, F., Janiesch, C., and Geyer-Klingeberg, J. (2019) follows the principle of design science research which includes

literature review, experts review and a survey based on the Analytic Hierarchy process. High degree of standardization and high volume are important to choose the process for automation.

Tello, G., Gianini, G., Mizousni, R., and Damiani, E. (2019) built a ML based framework to conduit the gap between event logs and process models. This framework consists of log segmentation and machine learning classification technique. Each segment corresponds to a high level activity. The segmentation algorithm is based on maximum likelihood with n-gram analysis. Event segments are mapped with the high level activities. Many ML classification Techniques were explored counting SVM, ANN and Random Forest. The dataset consists of event logs from a SAP company. Among all of these the random forest algorithm performs better than the other methods with an accuracy of 96.4%.

Huang, F., and Vasarhelyi, M. A. (2019) implemented RPA in auditing. The authors proposed a framework that helps auditors to get free from the repetitive and bored tasks and to guide the editors for applying RPA in their field. The framework's main tasks listed as: (i) Select suitable audit procedures, (ii) adjust the offered procedure,(iii) apply it in-house, and (iv) gauge the performance. RPA is a cost-effective method over multiple audit engagements. UI Path tools are used to implement RPA in auditing. AI infusion in this research would be a future feature of this study. Because Intelligent Process Automation (IPA) uses AI to understand how people make decisions, and then learn it by doing the transactions. This leads to complete complicated jobs faster and more accurately.

Martins, P., Sá, F., Morgado, F., and Cunha, C. (2020) proposed an integration of deep learning and RPA to increase the cognitive skills of our virtual software agents. The researcher has created an application which automates the dynamically detection of objects in different software interfaces using Convolution Neural Network. These interfaces could be of Windows 10 operating system, Netbeans IDE. To implement this, a neural network is trained to detect objects and to further do complex tasks like writing RPA application to install operating systems, configuring servers, installing softwares. This approach is different from the traditional approach where in screen scraping tools are used by our software robots

to mimic the human behavior. A list of frameworks is proposed to implement the CNN API's like PyTorch, Caffe2, Microsoft Cognitive Toolkit, and MatLab. The dataset consists of 10.000 snapshots of different application software interfaces, tools, configuration panels, and web pages. The discrete test set was designed to perform testing. The first set was to identify different versions of programming IDE's. The detection rate was 95.6% in this case. The second test set was focusing on different colors, components on screen. The average precision was in between 73% to 93.32%. In the third test the images and component's size was changes to access the losing quality. Future work consist of creating more larger dataset, usage or RPA with more advanced AI skills like the software robots should automatically install and configure applications and actuation.

Leno, V., Augusto, A., Dumas, M., La Rosa, M., Maggi, F. M., and Polyvyanyy, A. (2020) introduced a concepts towards Robotic Process Mining (RPM) Tool to discover automatable routines from User Interaction Logs (UI Logs). These RPM tools are used to generate RPA scripts from UI logs. The jobs were divided into three phases using an RPM pipeline: 1) UI log collection and pre-processing; 2) candidate routine identification; and 3) executable routine discovery. In UI log pre-processing phase, removal of noisy logs and segmentation is done. Segmentation process is used to identify the boundaries of the task traces. In the second phase repetitive sequences of actions are identified and these actions are ranked to prioritize the automation potential of the process. In the third phase the RPA scripts are generated to perform the automation. The researcher also explains the research challenges for all the three phases.

Augusto, A., Conforti, R., Dumas, M., La Rosa, M., Maggi, F. M., Marrella, A., ... and Soo, A. (2018) focused on process mining techniques to extract the insights of the business processes with automated process discovery. These techniques analyzed the event logs of the process, and produce a business process model by capturing the control flow events from the event log. A systemic review is done for all the automated process discovery methods available by twelve publically available real – life event logs.

2.1 Gaps in study

i. Robotic Process Automation (RPA) is an emerging field with proven success in terms of increasing return on investments, cost reductions, and improved business processes. A report by McKinsey and Company (Manyika, J., Chui, M., Bughin, J., Dobbs, R., Bisson, P., and Marrs, A., 2013) estimates that around 110 to 140 million Full-Time Equivalents (FTE) will be substituted by automation tools by 2025. However the primary concern for organizations is to identify, which business process to automate (Leopold, H., Aa, H. V. D., and Reijers, H. A., 2018). In literature, different strategies have been discussed to identify the degree of automation in business processes like RPM-based (Leno, V., Polyvyanyy, A., La Rosa, M., Dumas, M., and Maggi, F. M., 2019), process quality-based, and surveys & discussion-based. However, there is a lack of a standard framework to pick up candidate processes among various processes of an organization to realize the benefits of RPA (Leno, V., Augusto, A., Dumas, M., La Rosa, M., Maggi, F. M., and Polyvyanyy, A. (2020).

ii. There is a lack of uniform practices to pick processes for automation. Standard parameters and metrics need to be developed by using a combined approach of these three process selection strategies for RPA implementation (Wanner, J., Hofmann, A., Fischer, M., Imgrund, F., Janiesch, C., and Geyer-Klingeberg, J., 2019).

iii. Testing the software bots is one of the key aspects of the thriving realization of RPA projects. Software bots need to be tested for scalability and reliability. Testing provides an assurance that the bots will not disturb the underlying Information system and hence is secure and ready to be implemented. Standard techniques need to be developed for automation testing of software robots without affecting the real production environment (Van Der Aalst, W. M. P., Bichler, M., and Heinzl, A., 2018).

iv. Proper Monitoring and controlling of the software bots after deployment to reduce the deviations is lacking (Aguirre, S., and Rodriguez, A., 2017).

v. RPA can automate tasks, which are generally manual and repetitive. It mimics the behavior of the activities performed in a process. The RPA lack in providing intelligent automation (Martins, P., Sá, F., Morgado, F., and Cunha, C., 2020).

3. Description of Broad Area

Robotic Process Automation (RPA) is a “virtual software agent” or “software bots” that mimic human behavior. It is configured and deployed on organization’s software to do the repetitive tasks that is originally be developed by humans.

3.1 Problem Formulation:

The lack of criteria for candidate process selection for RPA projects is a constant source of frustration for the RPA. The RPA implementation in existing information systems is quite expensive, hence more advanced and standard techniques like a model or a framework should be used to identify the processes to automate. Various strategies have been developed to aid in the identification of processes that should be automated. This research aims to propose a framework to choose and prioritize the candidate business processes for RPA implementation and to develop standard criteria to assess the automation rate of a process. Further, the work aims to apply the proposed solution with the help of AI & ML to perk up the decision- making power of virtual agents of RPA so as to enhance the cognitive skills of robots.

4. Research Objectives:

The objectives of this research are to discover the Candidate Routines for RPA using ML cognitive capabilities and the following can be summarized:

i. To study and compare various types of candidate process selection strategies and their challenges.
ii. To develop standard criteria for process selection strategies for implementation of RPA
iii. To discover a consistent framework to establish uniform practices to prioritize or select business processes for automation.
iv. To create the proposed model with AI and ML to improve the cognitive capabilities of Software Robots.

5. Research Methodology:

5.1 Architectural Flow:

There are three phases to selecting candidate processes for RPA implementation:

i) RPM, ii) Process -based quality characteristics, and iii) Interviews and discussion-based methods. The basic architecture and content of the information is shown in Fig.1 Flow diagram:

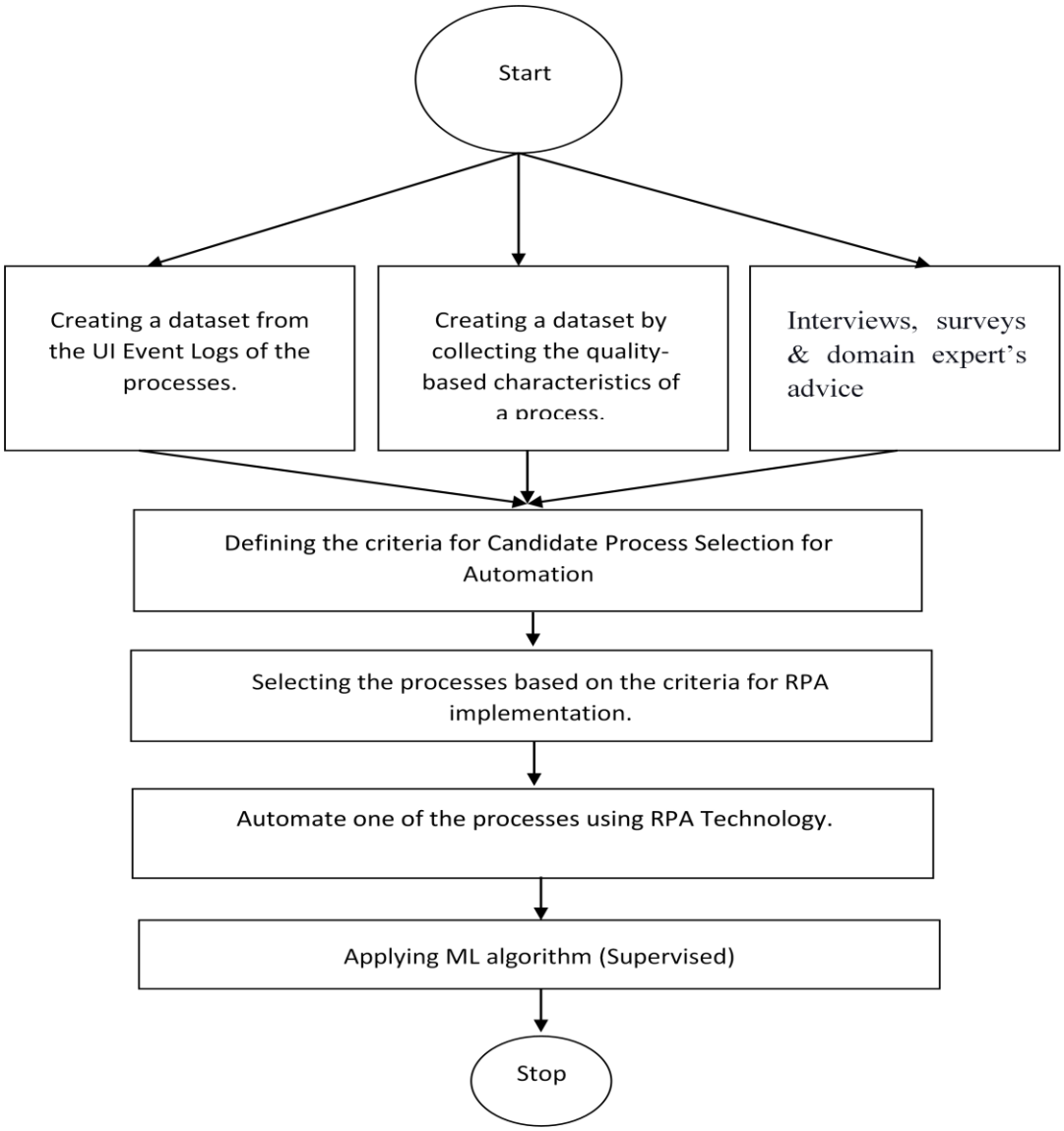
Start
Creating a dataset from the UI Event Logs of the processes.
Creating a dataset by collecting the quality-based characteristics of a process.
Interviews, surveys & domain expert's advice
Defining the criteria for Candidate Process Selection for Automation
Selecting the processes based on the criteria for RPA implementation.
Automate one of the processes using RPA Technology.
Applying ML algorithm (Supervised)
Stop

Fig.1: **Flow diagram,** source:self

Dataset Generation Phase: The dataset for the RPM technique is collected by the User Interface (UI) event logs. These UI event logs are available online and from other reliable resources according to the required features described in Table 2. The UI event logs for the case study will be created by using Python, C#.net, Microsoft Azure, and ASP.net.

-Process-based quality characteristics are acquired by assigning binary values (0, 1) to each quality that exists in a process.

- Interviews and conversations with domain experts will provide the rest of the information.

i. **Data Cleaning and feature selection Phase**: This phase consists of data cleaning and formatting. After this analysis, features are selected for developing criteria for process selection.

ii. **Defining Criteria**: Next is the most important phase, which defines the criteria for identifying candidate routines in business processes. A framework is developed using these criteria.

iii. Selecting the processes based on the criteria for RPA implementation: In this phase the suitable process will be identified according to the criteria using the framework. These criteria will be applied on all the processes of the case study.

iv. **Applying Machine Learning Algorithm**: To improve the decision making process of a software robot, Supervised Machine Learning algorithm will be applied after collected the training and testing data from the selected processes.

Table 2: Event Logs, source: self

Case ID	**Activity Name**	**Timestamp**	**Resource**	**Cost**
123	Insurance Claim	2-2-2022@10:40	Priya Sharma	140.00

5.2 Tools and Technologies to be used:

Platform: .net Framework, Microsoft Azure

Model Training: Supervised Machine Learning Methods (Decision Trees)

Dataset: UI Logs from open-source Benchmark and GETS Technology Application

Tools: UI Path Automotive Tools, WEKA, WordNet

Programming Technology: C#.net, ASP.net, Python

6. Expected Outcomes of the Research:

To provide better results and outcomes in terms of defining the criteria to select the candidate processes for RPA implementation in an organization.

- Specify the criteria for Candidate Process Selection Framework.
- Provide a model to analyze, identify, prioritize and select suitable process candidates for the automation with RPA.
- Implementation of AI & ML to improve the cognitive capabilities of Software Robots.

References:

Accenture, 2016, Getting Robots Right: How to avoid the SIX most damaging mistakes in scaling up Robotic Process Automation.

Aguirre, S., and Rodriguez, A., 2017, Automation of a business process using robotic process automation (RPA): A case study, In *Workshop on engineering applications*, pp.65-70, Springer, Cham.

Asatiani, A., and Penttinen, E., 2016, Turning robotic process automation into commercial success–Case OpusCapita, *Journal of Information Technology Teaching Cases*, *6*(2), pp.67-74.

Augusto, A., Conforti, R., Dumas, M., La Rosa, M., Maggi, F. M., Marrella, A., ... and Soo, A., 2018,

Automated discovery of process models from event logs: review and benchmark, *IEEE transactions on knowledge and data engineering*, *31*(4), pp.686-705.

Business Process Model Notation, n.d., https://www.bpmn.org/.

Celonis, n.d., *Process mining in cloud*, https://academiccloud.celonis.com

Chakraborti, T., Isahagian, V., Khalaf, R., Khazaeni, Y., Muthusamy, V., Rizk, Y., and Unuvar, M., 2020, From robotic process automation to intelligent process automation, In *International Conference on Business Process Management*, pp. 215-228, Springer, Cham.

Geyer-Klingeberg, J., Nakladal, J., Baldauf, F., and Veit, F., 2018, Process Mining and Robotic Process Automation: A Perfect Match, In *BPM (Dissertation/Demos/Industry)*, pp.124-131.

Huang, F., and Vasarhelyi, M. A., 2019, Applying robotic process automation (RPA) in auditing: A framework, *International Journal of Accounting Information Systems*, *35*, 100433.

Jha, N., Prashar, D., and Nagpal, A., 2021, Combining artificial intelligence with robotic process automation—an intelligent automation approach, In *Deep Learning and Big Data for Intelligent Transportation*, pp.245-264, Springer, Cham.

Jimenez-Ramirez, A., Reijers, H. A., Barba, I., and Valle, C. D., 2019, June, A method to improve the early stages of the robotic process automation lifecycle, In *International Conference on Advanced Information Systems Engineering*, pp. 446-461, Springer, Cham.

Juntunen, K., 2018, Influence of contextual factors on the adoption process of Robotic process automation (RPA): Case study at Stora Enso Finance Delivery.
Kohli, R., and Melville, N. P., 2019, Digital innovation: A review and synthesis, *Information Systems Journal*, *29*(1), pp.200-223.

Lacity, M. C., and Willcocks, L. P., 2016, A new approach to automating services, *MIT Sloan Management Review*, *58*(1), pp.41-49.

Lacity, M., and Willcocks, L., 2021, Becoming Strategic with Intelligent Automation, *MIS Quarterly Executive*, *20*(2), pp.1-14.

Le Clair, C., Cullen, A., and King, M., 2016, Digitization leaders share robotic process automation best practices, *Enterprise Archit. Professionals, Forrester Res., Cambridge, MA, USA, Tech. Rep. E-RES134021*, pp.1-12.

Le Clair, C., Cullen, A., and King, M., 2018, The Forrester Wave™: Robotic Process Automation.

Leno, V., Polyvyanyy, A., La Rosa, M., Dumas, M., and Maggi, F. M., 2019, Action logger: Enabling process mining for robotic process automation, *CEUR Workshop Proceedings*.

Leno, V., Augusto, A., Dumas, M., La Rosa, M., Maggi, F. M., and Polyvyanyy, A., 2020, Identifying candidate routines for robotic process automation from unsegmented UI logs, In *2020 2nd International Conference on Process Mining (ICPM)*, pp.153-160, IEEE.

Leopold, H., Aa, H. V. D., and Reijers, H. A., 2018, Identifying candidate tasks for robotic process automation in textual process descriptions, In *Enterprise, Business-Process and Information Systems Modeling*, pp.67-81, Springer, Cham.

Manyika, J., Chui, M., Bughin, J., Dobbs, R., Bisson, P., and Marrs, A., 2013, *Disruptive technologies: Advances that will transform life, business, and the global economy*, Vol. 180, pp. 17-21, San Francisco, CA: McKinsey Global Institute.

Martins, P., Sá, F., Morgado, F., and Cunha, C., 2020, Using machine learning for cognitive Robotic Process Automation (RPA), In *2020 15th Iberian Conference on Information Systems and Technologies (CISTI)*, pp.1-6, IEEE.

Primer, A., 2015, Introduction to Robotic Process Automation, *Institute for Robotic Process Automation.*

Sicular, S., Brant, K., and Gartner, G. I., 2018, Hype cycle for artificial intelligence, 2018, *Edited by Gartner I. Gartner*, pp.1-73.

Tello, G., Gianini, G., Mizousni, R., and Damiani, E., 2019, Machine learning-based framework for log-lifting in business process mining applications, In *International Conference on Business Process Management*, pp.232-24, Springer, Cham.

The Institute for Robotic Process Automation, 2015 , *Introduction to robotic process automation: A primer*. URL:https://irpaai.com/wp-content/uploads/2015/05/RoboticProcess-Automation-June2015.pdf

UiPath, n.d., *what is process mining*. https://www.uipath.com/rpa/what-is-process-mining

UiPath, n.d., *The Evolution of Robotic Process Automation (RPA): Past, Present, and Future*, https://www.uipath.com/blog/rpa/the-evolution-of-rpa-past-present-and-future

Van Der Aalst, W. M. P., Bichler, M., and Heinzl, A., 2018, Robotic Process Automation, *Business & Information Systems Engineering, 60 (4), pp.269–272*

Wanner, J., Hofmann, A., Fischer, M., Imgrund, F., Janiesch, C., and Geyer-Klingeberg, J., 2019, Process selection in RPA projects–towards a quantifiable method of decision making.

Willcocks, L., Lacity, M., and Craig, A., 2017, Robotic process automation: strategic transformation lever for global business services?, *Journal of Information Technology Teaching Cases*, *7*(1), pp.17-28.

Willcocks, L. P., Lacity, M., and Craig, A., 2015, The IT function and robotic process automation.

Willcocks, L. P., Lacity, M., and Craig, A., 2015, Robotic process automation at Xchanging.

Willcocks, L., Lacity, M., and Craig, A., 2016, Robotic process automation at telefónica O2, *MIS Q Exec*, *15*(1), pp.21-35.

Discovering the Candidate Routines for Robotic Process Automation using Machine Learning Cognitive Capabilities

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SHORT SYNOPSIS

by

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Under the supervision of
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ABSTRACT

Automation and Digitization are the highest strategic agenda for many giant organizations. Businesses are rushing to find new ways to automate their business procedures. The dawn of new technologies ushered in a new era of advanced business acronyms in the way of working. Artificial Intelligence (AI) and its related technologies, such as Natural Language Processing (NLP), Computer Vision, Machine Learning (ML), and Robotic Process Automation (RPA), have given rise to a completely new method of Business Automation.

The RPA is a software solution that mimics human behavior, similar to a "Software ROBOT", and is configured and programmed to perform repetitive organizational tasks normally performed by humans. The RPA is an emerging field that focuses on automating business operations with deterministic outcomes and repeated routines. The RPA is used to validate business proposal contracts, consumer credit lines, insurance premium sales, and maintain personnel data.

Business giants like Telephonic O2 and Xchanging have seen their costs reduced by 30 percent and 800 percent, respectively, as a result of RPA deployment. The RPA has a lot of value and potential, but it also has some drawbacks. The first hurdle is to identify a business process that can benefit from RPA. The second task is to use AI-enabled technology to improve RPA's cognitive abilities. Using Robotic Process Mining (RPM) and Process Quality-based characteristics, this research intends to offer a framework and develop standard criteria for evaluating the automation potential of business processes. The next goal

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